DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Edited by A. S. RUSSELL, M.C., D.Sc.

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DISCOVERY

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EDITED BY A. S. RUSSELL, M.C., D.Sc.

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No. 1. JANUARY 1920

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SCIENCE PROGRESS owes its origin to an endeavour to found a scientific journal containing original papers and summaries of the present state of knowledge in all branches of Science. The necessity for such a journal is to be found in the fact that, with the specialization which necessarily accompanies the modern development of scientific thought and work, it is increasingly difficult for even the professional man of science to keep in touch with the trend of thought and the progress achieved in subjects other than those in which his immediate interests lie. This difficulty is felt by teachers and students in colleges and schools, and by the general educated public interested in scientific questions. SCIENCE PROGRESS claims to have filled this want.

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Editorial Notes

WITH these notes we introduce DISCOVERY. The journal has for its aim a popular description of the advance made in the chief subjects in which investigations are being actively pursued. We hope to give also, from time to time, some account of new ideas in subjects which do not lend themselves to definite and concrete "discoveries" as ordinarily understood, but in which new methods and new points of view, of interest and importance to everyone, are being developed. The articles, singly or in a series, will deal with their subjects in such a way as to make clear the interesting features of the discoveries with which they deal, and will be written in plain, simple language by contributors who can speak with authority in their own branch of knowledge. The general reader, who has neither time nor opportunity to pursue specialised study, will thus be able to obtain at first hand an account, which he can understand, of the chief things which the experts are doing or have done in all the chief branches of knowledge.

* * * * *

Our aim is to interest the reader, not to preach any special doctrine, or to lecture on any particular subject. We are not, therefore, narrowing our attention to a few subjects, whether literary or scientific, but mean to take all knowledge as our province. Of course, in any particular number the limits of space will confine us to a few subjects only; but in time we hope to cover all subjects in which discoveries or new points of view are of sufficient interest to be described. At the present moment, while there are many periodicals which are written for specialists by specialists, and many more in which popular descriptions of discoveries are given by journalists, there is none in which the vast amount of new work and of new ideas in various subjects is described, either by the men themselves who are doing the work, or by men who are "inside" the subjects they are writing about. We hope to get such men to write for DISCOVERY, and to write not in the language of their specialism, but in that simpler tongue which we plain men do understand—namely, English.

* * * * *

Our object, then, is to give readers an interest both in the Sciences and in the Humanities by making the work of the specialists in both as plain as possible. Whether we fail or not remains to be seen. We mean to try. It is a thing worth trying for. In the past, unfortunately, there has been considerable opposition between the representatives of science and those of the humane studies. Now, since the war, it is becoming abundantly recognised that the interests of these two somewhat artificial divisions of knowledge are not hostile, but complementary; and that the welfare of everybody depends upon advances being made in both of these, and on our recognising the necessity of both.

* * * * *

With increase in knowledge there has been a tendency for the specialist to separate himself from the amateur, the consequence being that the former works with, and on behalf of, a small hierarchy of kindred spirits, which has little or no dealings with outside people. The biggest things which these specialists do may, of course, become known after a time—often a very long time; but there are many interesting facts, theories, and points of view, not of such capital importance, which never come into the ken of the

ordinary man or woman at all, simply because there is no easy channel of communication.

* * * * *

It is easier to suggest what these channels are, than to get the right people to make use of them. Popular lectures in the past have been a very useful means to the end we are seeking. When the lecturer really knows his subject, possesses a good voice and lantern slides, and, without telling his audience too much, keeps his remarks cheerful and witty, he gets an attentive hearing. But books and magazine articles must needs be the chief means of information. We hold that the specialist, when he has communicated his results to his fellow-workers in the ordinary way, should do the further work of making the same results plain to the ordinary man in books, pamphlets or articles easily understood. To review and recommend such books when they seem suitable, and to print such articles, is part of the work we have undertaken in bringing out DISCOVERY.

* * * * *

Having thus briefly described our aims, our intentions and our hopes, we may be allowed to describe shortly how DISCOVERY came into being. The first conception of the journal was due to the late Professor Julius Macleod, of Ghent, a distinguished Belgian botanist, who was a guest of the University of Manchester during the war. His suggestion led to a special conference between a committee of the Council of Humanistic Studies and a committee of the Conjoint Board of Scientific Studies. As a result of this conference, negotiations were commenced, which have since developed until the project has taken its present shape. In October of last year, it was decided that the magazine be maintained under a deed of Trust, the Presidents of the Royal Society and of the British Academy being two of the four trustees. It was decided also that the committee of management be composed of representatives of bodies which have joined in a guarantee of the initial expenses, and also of representatives of learned societies. The former bodies include the National Union of Teachers, the Co-operative Union, the Library Association, the Incorporated Associations of Headmasters and Headmistresses, and the Headmasters' Conference: the latter the Conjoint Board of Scientific Societies, the Classical, Historical, English, Geographical and Modern Language Associations, the British Psychological Society and the Royal Society of Economics. Each of these specialist bodies undertakes to supply, year by year, for our use, a list of contributors who are capable of representing its particular branch of knowledge in articles of a popular kind. We are thus doubly equipped in a way that few new periodicals have been. To a large extent we have found our contributors; to some extent our public awaits us. With this solid phalanx of good men to help us, we hope we have

"Caught soul
For the goal."

We shall welcome correspondence relating to the subject-matter of the articles, and also suggestions and criticism that may lead to the more complete fulfilment of our aims and intentions. A short list of books suitable for further study will be appended in most cases to an article. We hope these will be found useful. Occasionally, as in this number, it may happen that a writer recommends his own book. In such cases, it will be understood that the book mentioned is the best procurable, and has been given at our suggestion.

New Light on Old Authors

I. The Secret of Philæ

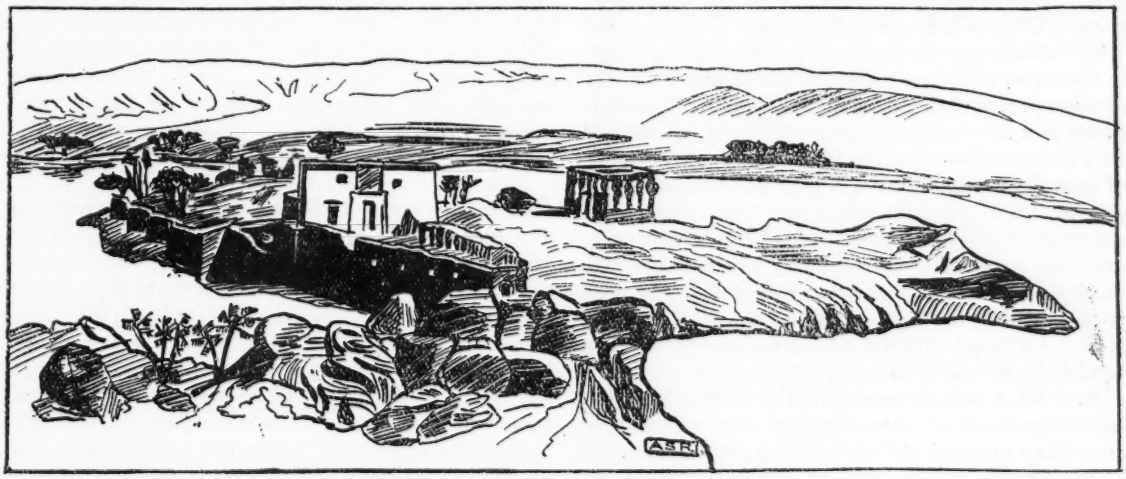
By R. S. Conway, Litt.D., F.B.A.

Hulme Professor of Latin in the University of Manchester

PHILÆ, the most famous island in the Nile valley, contains, as our illustration shows, several ancient temples, the oldest and most conspicuous having been built about 300 B.C. But all the visitor to-day can see of them is the summits of the tallest. The rest is now covered with water through the creation of the great reservoir by the new barrage of the river at Assouan. This colossal feat of British engineering is a permanent service to Egypt, since it has rendered perpetual what for untold centuries had been a matter of anxiety to the Egyptian nation every year, a full supply of Nile water to fertilize the fields; and some account of it may well be given in this journal on another occasion. This article is concerned merely with one of the many additions to our knowledge which has resulted from the survey of the ancient remains of the Nile Valley, which was begun and continued for many years by the Egyptian Government to anticipate the coming flood.

At the north-west corner of the island, which appears on the left-hand side of the illustration, there once stood a temple which has long since been almost levelled to the ground, but which in its day was the first thing on the island to meet the eyes of a traveller arriving from Europe. This, as we know from the inscription on its fallen portico, was built twelve years before the birth of Christ, to the honour of the Emperor

Augustus Cæsar, who had been supreme in Egypt since the defeat of the last Egyptian sovereign, Cleopatra, at the battle of Actium nineteen years before; the story of her death is, of course, familiar to English readers from the vivid scenes of Shakespeare's *Antony and Cleopatra*. After Cleopatra's death, Augustus had to decide the question to whom he should depute the government of the country, since it was a vitally important part of his Mediterranean system, and one of the chief sources of the corn-supply of Rome. He chose a young poet named Gaius Cornelius Gallus, who had won distinction also as a commander in the civil wars. Some of Gallus' own brilliant but uneven writing has lately become known to us, in a poem called the



PHILÆ AND ITS TEMPLES IN 1900; FROM BIGA, LOOKING N.E.

Ciris, now shown, quite certainly as some of us think, to be mainly his work. We know him to have been the school-companion and an intimate friend of a greater writer of his own age, the poet Vergil.[1] Now, Vergil was born and bred a farmer's boy, on the estate of which his father was at first only the steward, though later the owner; and one of his greatest poems, still read by thousands of boys and girls at school every year, is a description of the work which farmers do and its importance in human life as a whole. This poem Vergil called *Georgica*, that is, "Farming." His chief purpose in writing it was to describe the country-life he knew and loved; but incidentally he meant it to support the plans of the Emperor for restoring agriculture in Italy. The simplest and most familiar of its four Books is the last, which sets out to describe the keeping of Bees, and discourses profoundly and yet playfully on that topic for about three-fifths of its length. But at that point the poem takes a strange turn and relates, in quite a different style, two or three old-world legends, very slightly strung together and still more slightly connected with the keeping of Bees. The chief of them is the famous story of the singer Orpheus, who went down to the World of the Dead to fetch back his beloved Eurydice, and lost her again because he looked back upon her too soon. This short poem, which is really complete in itself, is so beautiful and has seized the imagination of so many poets—not to mention the musicians—of later ages, that people have read it gratefully where it stands, without troubling themselves with the curious question why Vergil should have tacked it on to a poem about Farming. Indeed, in the nineteenth century most Latin scholars—especially in Germany, though not only there—were accustomed to pooh-pooh the explanation of it given by the commentator Servius, who lived in the fourth century, though nearly all his positive statements about Vergil are drawn from much earlier writers who knew Vergil himself. But this explanation has now been confirmed, past all dispute, by the discovery in 1896 of an inscribed stone built into the paved approach to the temple of Augustus which, as we have seen, was built at Philæ; and few discoveries have thrown more direct light on the critical period in the world's life that just preceded the birth of Christ, or on the inner experience of one of the greatest, if not the greatest, of the world's poets. But though the stone was found in 1896, none of the editions of Vergil printed or reprinted since then, and probably none of all the teachers concerned in interpreting him to English schoolboys, make any mention of it.

What, then, does Servius tell us about the end of Book IV of the *Georgics*? Originally, he says, the

[1] The Italian form *Virgilio* gave *Virgil* in English, but most scholars now prefer to follow the Latin form of the name, which was *Vergilius*.

conclusion contained an account of Egypt, including its production of honey, and " the praises of Gallus " ; but after Gallus had fallen into disgrace and committed suicide, Vergil substituted the present ending with the stories of Aristæus and Orpheus. The explanation is, in fact, by no means hard to accept ; for no account of farming in Vergil's time could have altogether omitted Egypt, then the world's greatest granary ; nor could any poem whose author desired to help Augustus have been altogether silent about his addition of that famous and ancient kingdom to the Roman Empire ; nor can anyone who has realized the kind of man Vergil was, and the kind of affection he had for his friends, imagine that he could have failed to notice the fact that the newly added realm was governed by his friend and fellow-poet Gallus.

Nevertheless our pastors and teachers who belonged to the epoch of Mommsen (when it was almost a point of honour to reject every ancient statement against which even the faintest doubt could be raised), though they did not indeed deny that Gallus had been governor of Egypt and had fallen out of power, would not recognize this as a sufficient basis for Servius' story, and wrote of Vergil and Gallus as though they belonged to different worlds, instead of being what they surely were, the David and Jonathan of their day. Perhaps unconsciously they were influenced by the desire not to connect Vergil so intimately with a man whom they regarded merely as a traitor.

Now, what does the inscription of Philæ add to our knowledge ? It gives us the very words written to record the victories of Gallus, in Egyptian, Latin, and Greek ; those in Latin at least being certainly what Gallus himself wished to state. He makes a votive offering to " the gods of his country and to the River Nile who aided him," and describes himself in flowery, poetical language as " the subduer of the whole Thebaid region in fifteen days " ; as " having carried his armies above the cataract of the Nile to a spot never before reached by the Roman people or by Egyptian Kings," as having " inspired with terror all the chieftains of the region," and taken five cities (now lost in the desert sand). All this Gallus has done ; whereas his imperial master receives only a brief mention at the beginning as having " conquered the Kings of Egypt "—that is, Cleopatra and (probably) Antony.

And what was the large portrait cut deep in the stone in the centre of the inscription ? It represented someone on horseback riding down upon a suppliant foe—and Gallus was a Roman knight—but the features have been deliberately hacked out. For what reason ? For the same reason which led the builders of the Temple of Augustus to place the whole slab with the inscription face upwards to be trodden on by everyone who approached to worship at the Emperor's shrine—namely, to do dishonour to Gallus ; it was Gallus' own picture that Gallus the prefect set up, and that his successors cast down and defaced ; and to set up one's own portrait in the East in ancient times was to claim for it something like divine honours. Now we see the boyish vanity into which the young poet-soldier was betrayed, partly no doubt by his first experience of the flattery of Oriental attendants, partly by his own love of glorious words ; and we see also how fatally easy it was for his enemies to misrepresent his attitude towards the Emperor.

One curious circumstance indeed reveals, almost by accident, what Gallus' inscription looked like to people in Egypt, and what a real danger it was, in fact, to the supremacy of Augustus for his lieutenants to be so boastful. The Egyptian inscription, which comes first, makes no mention, so the Egyptologists assure us, of Gallus' own name, but summarizes the events briefly and gives the credit either to Cæsar himself or " the præfect of Cæsar," if that be the right restoration of the Egyptian text. This was the true and old Egyptian fashion, and may, indeed, have been done with Gallus' approval or even at his command ; but to anyone who could understand the Latin or Greek as well as the Egyptian the contrast would be striking ; and to everyone, the appearance of Gallus' own portrait, not that of the Emperor, in full Roman style, between the names of six Egyptian deities, would be not less startling. Poor Gallus ! Like many another lad of brilliant powers and quick imagination, he lacked the sense of proportion without which no man is safe in high places, least of all in the East. Gallus was accused before the Senate and deprived of his command ; and learning that Augustus had expressed displeasure at what he had done, he killed himself. But the Emperor wept when the news was brought to him, and complained bitterly that he alone of all men was not allowed to be angry with a friend without some tragic consequence. The inscription which Philæ has preserved for us shows in every line the real nature of the tragedy. With no thought of treason to his master, though with no sense of the restraints which his own position demanded, the young Provençal poet plunged into a folly which even veteran statesmen have found it hard to resist. But his folly was not one that greatly lowers our regard; still less can it have robbed him of Vergil's affection, alien though it was from Vergil's own temper. With Gallus' words and his expunged portrait before us we understand the pathos of his fall—how innocent he seemed to himself, how guilty to everyone else. And we understand something of the tragic disappointment and lifelong sorrow of his friend Vergil, and something of the bitter regret of the Emperor. And it is no longer strange, but perfectly natural, that after such a tragedy, the name and achievements of Gallus could not

remain to make the climax of a great poem written by Vergil, and written partly in aid of one of the Emperor's great patriotic schemes. It is no longer strange, but perfectly natural, that, in piecing together three youthful poems (*Aristæus*, *Proteus*, *Orpheus*) to take the place of the lost *Praises of Egypt and of Gallus*, ingenious as the links inserted between them are, the great poet should have had no heart in his work, and should have left in despair the many broken threads of the supposed story to be a silent record of the bitterest sorrow of his life.

NOTE.—Some account of the Greek and Latin inscriptions was given in the *Athenæum*, March 14 and 21, 1896. Professor Sayce discussed the Egyptian text in the *Academy* shortly afterwards. Mommsen wrote an article in German in *Cosmopolis* (London, 1896, p. 545), in which he is characteristically silent about the statement of Servius. The best book for students to consult is *Aus Vergils Frühzeit* (pp. 140 ff., Leipzic, 1901), by the late Professor F. Skutsch, of Breslau, whose work in this and in many ways opened a new epoch in the study of Vergil. Some account of Gallus and his relations with Vergil will be found in a recent lecture of my own called *The Youth of Vergil* (Manchester, 1917).

Smoke Screens at Sea

By T. Slater Price, O.B.E., D.Sc.

Lieut.-Commander R.N.V.R.; Head of Chemistry Dept., Birmingham Municipal Technical School.

IN land warfare smoke screens have been used from the earliest times for the purpose of hiding operations in the field, but it was only during the recent war that serious attention was given to the subject and attempts made to put it on a proper scientific basis. In the navy, the method of producing a thick black smoke, which can be emitted in great volume from the funnels, has long been known, and tactical use made of it when occasion demanded. During the war, however, as the necessity arose for counteracting the submarine warfare of the enemy against defenceless merchantmen, and of undertaking operations against land stations defended by modern resources, new methods of producing smoke had to be devised. These methods had, in many cases, to be independent of any mechanical arrangements or motive power on board ship, since when the vessel was being chased by a submarine, for example, it was an advantage for it to be able to throw overboard a float containing the smoke-producing mixture, and thus hide its own course in the screen produced.

It is obvious that one essential condition to which a smoke screen must conform is that of remaining near to the surface of the water or land. This condition is perhaps more easily satisfied on sea than on land, since on the latter, during the time when smoke screens are of use—that is, in the day-time—the tendency is for the ground to be hotter than the air above it; the result is that hot air is rising upwards continually, and these upward currents tend to make any smoke screen rise. This effect is particularly noticeable on a bright, sunshiny day. On the other hand, over the sea the temperature gradient in the day-time is generally such that the air near the sea is colder than the superincumbent air, and the sea itself is at a lower temperature than the air in contact with it. A smoke cloud at sea will therefore tend to keep near the surface much more readily than is the case on land.

It is easily seen that, in order best to satisfy the condition under consideration, the particles of the cloud should be fairly heavy; they must not, however, be too heavy, otherwise the cloud will sink too rapidly into the sea and thus lose its effectiveness as a screen. It is very advantageous if the particles are of a hygroscopic nature, since there is then a tendency for the cloud to become thicker for some time after it has been produced, and not dissipate so quickly. In accordance with this, it has been found on land that a denser and lower cloud is formed when the atmosphere is nearly saturated with moisture than when it is fairly dry; the conditions over the sea are consequently more advantageous in this respect than over land.

The velocity of the wind has a marked effect on the smoke; clouds which would tend to rise if produced in still air, or in a low breeze, will be kept well down when there is a good breeze blowing. It must be remembered, however, that a cloud dissipates more quickly in a wind of high than in one of low velocity, so that for the same screening effect a much greater amount of smoke must be generated in a given time in a high wind than in a low one. This action of the wind in keeping down the smoke is of very great importance. Usually a great amount of heat is generated in the reactions which produce some of the most satisfactory smokes; this gives rise to strong currents of hot gases, which would carry the smoke upwards were it not for the counter-action of the wind. When smoke is actually produced on board a ship under weigh there is the distinct advantage over land conditions that the smoke is sucked down to the surface of the water by the inrush of air created at the stern of the ship.

Before dealing with the various methods for making smoke, the question of measuring the relative opacities of different smokes may be briefly referred to. Measurements have been made, both in this country and in America, by determining the distances at which an electric lamp is just obscured; knowing the

quantities of material used in the production of the various smokes, their relative screening powers could then be calculated. These measurements have naturally been carried out in an enclosed space, and it is a moot point as to how far the results obtained are valid for the open air. The efficiency of a smoke screen depends to a great extent on the conditions of lighting, and on how the observer is situated with respect to the source of light. One has only to think of the case of a room lit by a window looking on to the street and covered with a screen or curtain of meshed material. In the day-time a person in the room is screened from observation from the outside, although he can observe everything going on in the street; at night-time, when the room is lit up by an inside light, the conditions are reversed.

The fuel smoke which is usually made by vessels of the fleet has already been mentioned. It has the characteristic of most black smokes—namely, that it is made of particles of unburnt or partly burnt carbonaceous matter, and is consequently far from heavy. It is dissipated fairly rapidly, and only forms an effective screen when continuously produced in large quantity.

Practically all the effective moke screens which were produced artificially were w ite, and mention will now be made of some of these.

The first introduction of a smoke-producing agent into the services involved the use of phosphorus, and special apparatus was designed by Sir Richard Threlfall for burning it at sea. The apparatus could be placed on deck and the phosphorus fired in position, or it could be modified in such a way that it floated when in the sea and could be left functioning while the ship proceeded on its course. There is no doubt that, weight for weight, phosphorus has a great advantage over practically all other smoke-producers, since only oxygen is necessary for its combustion, and this is available in the air in unlimited quantities. The particles of phosphorus pentoxide produced are exceedingly hygroscopic, and the cloud formed is a very good one, although, because of the heavy nature of the particles, it tends to settle somewhat rapidly. Owing to the great rise in temperature caused by the combustion of the phosphorus, there is a distinct tendency for the smoke to arch in low winds. This method of producing smoke was used with great success early in 1917 for the purpose of screening monitors when bombarding the Belgian coast. It was abandoned later, however, partly owing to the dangerous nature of phosphorus itself, when used on board ship, but chiefly because of the extremely bright light which is produced when phosphorus burns. The emission of this light makes it an easy matter for guns to be ranged on the vessel producing the smoke, and renders the method quite useless for night operations.

Since the supply of phosphorus was limited, and it was urgently needed by the army as a smoke-producing substance, the necessity arose of replacing it by some smoke-producing material which could be stored in appropriate floats on the decks of merchantmen or other vessels, the floats then being lit and thrown overboard when occasion demanded. The late Wing-Commander Brock, R.N., Commanding Officer of the Royal Naval Experimental Station, Stratford, E., devised a mixture which was really a firework composition, modified in such a way, by the addition of resinous and other carbonaceous material, that a dense smoke was produced on burning. This mixture was placed in tin canisters contained in a wooden box, each canister being connected by a fuse to a match composition (suitably protected) on the outside of the box, and which could be fired by friction. Near the top of the sides of the box were a number of small holes, that were plugged by a composition which would easily be blown out by the pressure set up in the box by the gases produced in the burning of the smoke mixture. The boxes were so arranged that they floated in water, the top side uppermost, and all that was necessary, in using them, was to strike the friction tab and then, when it was certain that they had started functioning correctly, throw them overboard. The results obtained were not very satisfactory, however, owing to the difficulty of keeping the boxes watertight, and the smoke-mixture free from moisture. Also, the smoke produced suffered from the same defects as the fuel-funnel-smoke.

There are several chlorides of metals and non-metals, such as stannic chloride, antimony pentachloride, silicon tetrachloride, etc., which give a good smoke when decomposed by the moisture of the atmosphere, or especially when a fine spray of the liquid is mixed with a fine spray of liquid ammonia; stannic chloride especially gives a very good cloud under such conditions (see English Patent 127289). To use these substances, however, they have to be stored in heavy steel cylinders under a considerable pressure of air, in order to force them out as a spray through a syphon tube; the dead weight of the containing-vessels is thus very large in comparison with the weight of smoke-producing material. Moreover, the contents of a cylinder are discharged in the short time of 6–8 minutes. This method of producing smoke is therefore not very convenient on a large scale, but it has the advantage that smoke can be produced instantly, and in quantity, by the mere turning of a tap.

A smoke mixture which has found extended use, and which depends on a principle not previously used, is that devised by Berger.

The English Patent 127031, which has been taken out by Berger, is somewhat as follows: "Fumes or

vapours for concealing military operations are produced by the combustion of mixtures of chlorides of metals or non-metals, or chlorinated hydrocarbon derivatives, with a metal, non-metal, or a sulphide, or with a mixture of an oxide and reducing agent, or with a mixture of an oxide, an excess of a reducing agent, and an oxidizing agent. For example, the mixture may contain tetrachlorethane 40, zinc oxide 20, zinc dust 15, calcium silicide 15, and sodium chlorate 10 per cent."

If carbon tetrachloride is used as the chlorinated hydrocarbon, the production of smoke really depends on its interaction with the zinc, zinc chloride thus being formed. In order to prevent the deposition of carbon at the same time, oxides are added, and the metals of these oxides, after furnishing oxygen to the carbon, are also transformed into chlorides and add to the smoke. Kieselguhr is often added, and this serves the purpose of absorbing the carbon tetrachloride, thus furnishing a pasty mixture which can readily be handled, and of which the constituents do not separate out. In order to start the reaction it is necessary to heat a portion of the mixture to a high temperature by means of a special thermite igniter. Once the reaction has started it proceeds with great vigour, and a dense white smoke is emitted in great volume. The particles of this smoke consist essentially of the hygroscopic chlorides of zinc and other metals, with the result that the cloud becomes denser a short time after it has been formed.

The Berger mixture could not be made in this country, since some of the necessary ingredients were not available in quantity. Extended series of experiments and trials were therefore carried out at the Royal Naval Experimental Station, Stratford, E., with the result that several different mixtures, containing ingredients which were available in quantity, were devised. These mixtures were manufactured on a large scale and filled into floats for use at sea. These floats consisted essentially of a cylindrical metal container, approximately 8 inches by 28 inches, surrounded by an air chamber of sufficient size and shape to make the whole thing float upright in the sea with a free-board of a few inches. The mixture, as soon as it was made, was put into the float and a lid soldered on. The lid contained a central, screwed hole, for the insertion of an igniter when occasion demanded; until required this hole was sealed by a screw plug. Around the central hole was a number of smaller holes or vents, closed by means of soldered-on tin discs. The method of using a float was to insert the igniter, strike the friction tab on the top, and then throw the float overboard. The delay in the fuse in the igniter was sufficient to allow the float to come to the surface of the water before the thermite really caught fire. As soon as the smoke mixture started burning the heat developed was sufficient to melt the solder fastening the tin discs over the vents, with the result that the latter opened, and smoke issued in volume from the vents and the central hole where the igniter had been. A single float would burn for 15–20 minutes, emitting a cloud which would extend as an efficient screen for 1,000 yards or more. With several floats a most satisfactory screen could be obtained.

Instead of throwing the float overboard, it could be burnt on deck if the wind conditions were satisfactory.

In order further to simplify the working of a float, an igniter was devised which was actuated by coming into contact with water. All that was necessary was to tear the cover off the igniter after it had been inserted in the float, and then throw the float overboard. The igniter contained a special chemical mixture which ignited as soon as it came in contact with the water; this fired the thermite, which then started the combustion of the smoke mixture.

There is no doubt that this mixture was also the most satisfactory for certain purposes on land, but it was not used to any great extent, as the supply of material was sufficient only for naval purposes. Successful efforts were made at Stratford to adapt it for use in Stokes bombs, and had the war continued it might have found extended application in that and other directions.

The last smoke-producing substance to which reference will be made is chlorosulphonic acid. It is well known that this substance fumes violently when exposed to moist air, and the Germans made use of this property in a stationary smoke apparatus for land purposes. Crude chlorosulphonic acid, or a mixture of chlorosulphonic acid and oleum, was contained in a drum suspended over a vessel containing quicklime. When the drum was turned over, the chlorosulphonic acid ran out through a hole on to the lime. The heat of reaction between the lime and the chlorosulphonic acid was sufficient to vaporize the excess of the latter, which was thus driven into the air and gave a dense smoke when the air was sufficiently moist. On a dry day, when the air contained very little moisture, the smoke was apt to be somewhat thin.

When the production of smoke from chlorosulphonic acid for naval purposes was discussed at Stratford, it was pointed out that the German method involved a considerable waste of smoke-producing material, which was used up in combining with the lime. Since there are numerous sources of heat on board ship, it was suggested that they should be utilized for vaporizing the chlorosulphonic acid and so forming smoke. This suggestion was accepted by Commander Brock, and after an extended series of experiments satisfactory

methods were developed. It should be noted that the best results can only be obtained if the chlorosulphonic acid is heated suddenly to a temperature above its boiling-point. If attempts are made to vaporize it by boiling, a partial decomposition takes place into sulphuryl chloride and sulphuric acid; the former decomposes very slowly with water vapour and is of very little use as a smoke-producing agent, whilst the latter gradually accumulates in the boiling liquid. In order to obtain complete success, it is furthermore necessary that the vapour of the chlorosulphonic acid, or its decomposition products, should come into immediate contact with an excess of water vapour. If attempts are made to use chlorosulphonic acid without supplying it with a sufficient amount of water vapour, the smoke produced, even over the sea, is liable to be somewhat thin on a dry day.

The conditions necessary for success were satisfied as follows, the particular methods of application being due to Commander Brock:

(*a*) The chlorosulphonic acid is fed as a fine spray into the funnel of a destroyer. The temperature of the waste products of combustion from the furnaces is sufficient suddenly to vaporize the acid, and the water vapour present completes the formation of the cloud.

(*b*) The chlorosulphonic acid is dripped into the exhaust pipe of a petrol engine on a motor-launch or coastal motor-boat. The effect is the same as in the funnels.

Both these methods were used with great success in the raids on Zeebrugge and Ostend. Method (*b*) was also adapted to land tanks, a number of these being fitted up by a special experimental party sent out from the Stratford Naval Station.

Another method by which a very good smoke can be obtained from chlorosulphonic acid is to force it through a special spray nozzle by means of steam, the acid and the steam being brought into contact just at the orifice of the nozzle.

It may be mentioned that the smoke produced by chlorosulphonic acid, when sufficiently dilute, is hard to distinguish from a sea mist, and no unpleasant effects are noticeable on the face or when breathing it.

Suggestions have often been received that ships should be able to protect themselves by smoke screens all the time they are in waters infested by enemy craft. This, however, is not a feasible proposition at present, since the carriage of the smoke materials would necessitate a very large additional load on the vessel. Such a project may ultimately be realized, but it may be pointed out that practically all the readily available substances capable of producing smoke are now known; whether satisfactory new substances will be discovered in the future remains to be seen.

The Modern Study of Dreams

By T. H. Pear, M.A., B.Sc.

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"It's only a dream," is a comment which most of us make frequently without realising what a challenge our utterance is to the twentieth-century psychologist. The educated scientific person of to-day generally thinks of the dream as a trivial, absurd and nonsensical structure. Yet it is interesting to note that the simple mind, uninfluenced by the teachings of materialistic science, has always believed in the dream's importance.

And to-day there exists a band of workers who once more regard the dream as deeply significant. They were recruited from a field of study in which at present there reign almost supreme those materialistic views which would belittle the dream—the realm of medicine. For doctors deliberately to choose to investigate fantastic, meaningless, trivial mental phantoms like dreams, when every medical school offers them rows of solid brains, thousands of microscope slides with nerve-cells and fibres already stained and mounted, when all round them are people suffering from serious mental disorders, when everyone knows that those disorders are in some way connected with the brain; does this not seem like fiddling while Rome burns?

The answer is simple: yes, if one asserts that the only way to discover the nature of mental occurrences is by examining their underlying bodily mechanisms; no, if one believes that a mental event can be examined by mental means, and explained in mental terms. But, a critic may ask, and in all seriousness and honesty, why not study the more orderly, more manageable events of the mind?

An answer may be given by an example taken from another field of science. Many years ago our critic might have wondered at the strange behaviour of a man who chose to fly a kite during a violent thunderstorm. Even at the time the kite-flyer could have given very cogent reasons for his action; nowadays every schoolboy understands that much of our modern knowledge of electricity was made possible by this apparently eccentric performance. But not only does the explanation of the thunderstorm now form part of an educated person's common sense, it helps us also to understand the more difficult problems of the workings of electricity in every-day situations. So it is with the dream; its processes are cruder than those of the mind doing its every-day work; it is controlled by less complex forces; its behaviour is therefore simpler and often easier to comprehend.

And the study of the dream has already carried its investigators some distance towards the understanding of those thunderstorms of the mind which men call insanity.

To say that the study of the dream lies to the credit of twentieth-century psychology is to make a statement almost startlingly precise; for the foundation-stone of this new structure of knowledge bears the year 1900, the date of the publication, in Vienna, of Sigmund Freud's *Traumdeutung* (*The Interpretation of Dreams*). To indicate in a few pages the significance for psychology of this pioneer work is difficult; to represent fairly Freud's theory in ten times this space is impossible. The reader therefore will understand that the few glimpses which this article may afford him must inevitably suffer from incompleteness and not a little angular distortion.

Freud's way of viewing, not the dream alone, but the whole world of mental events, is characterized by two important beliefs, both of which must be grasped if his standpoint is to be appreciated. The first is that all mental happenings are explicable in mental terms; that an account of them in terms of material processes occurring in brain or body may supplement, but can never replace, the other direct explanation. A dream, then, can be analysed into factors which are just the experience of the individual; the stuff, so to speak, with which the explanation deals is mental.

The second belief is that in the mind, as in the body, there is no room for the action of chance; all mental events are regarded as the results of preceding mental events, and as strictly determined by them. For Freud nothing accidental can ever happen in the mind. Every mental occurrence, however trivial, nonsensical or mad it may seem to others, or even to the experiencer himself, is the effect of preceding mental causes.

We may now attempt to explain the way in which a dream can be analysed by Freud's method. If the reader, when he reaches the latter part of this article, will bear in mind a distinction which will now be made, he will be in a position immeasurably superior to that of many of Freud's critics. This distinction is between the *manifest content* and the *latent content* of the dream. According to Freud, that which people commonly term "the dream," that conglomeration of experiences which they relate, not seldom with additions and suppressions, to a more or less appreciative breakfast-table audience, is merely the aspect of the dream which is "manifest" to them. It has been formed from material which at the time of dreaming was latent, hidden from consciousness, just as a Member of Parliament is the manifest representative of some of the opinions of numerous latent people called his constituents.

The way in which Freud formed this theory of the dual nature of the dream should not be difficult to understand by anyone who has ever detected in his own dreams the composite nature of some of the apparently new images which they contain. We may take one of the simplest examples from the writer's own collection. The dreamer noticed that the right-hand side-line of a Badminton Court was curved like a snake, and thought that, while this addition might make play more "sporting," it tended to spoil the game. On awakening he saw at once that this picture split up into two components: an actual Badminton Court to which, on the night of the dream, he had introduced a keen golfer, and a serpentine bunker which his enthusiastic guest had described to him.

Now Freud goes so far as to say that *all* dream-pictures, whether recognized as composite or not, are in reality made up of memories, and that not only is their combination effected according to definite principles, but that the combination itself performs a definite function.

To understand how it is possible to arrive at such a belief we must grasp the broad difference between two ways in which the mind can remember—by directed or by free association. If a man, looking at his blotting-pad, notices that it is thick, pink, oblong, new, and absorbent, this expression of the workings of his mind may not seem unusual, either to himself or to another. But if on glancing at it he should remark, "pink, sweet-pea, flower show, Wales, Criccieth, Prime Minister, politics, housing problem, huts, Pacific Islands," a spectator's comment might be that the list sounded like the ravings of a madman. It is improbable that he would realize how near to an accurate statement of fact he had been, and that the difference between a sane man's directed association and the maniac's apparently free association is merely one of degree. For the first list above was compiled by allowing the blotting-pad to dominate the thinker's mind; the second by employing the blotting-pad simply as a launching-place for the memories which were then allowed to run freely.

But *were* these memories "free"? To the ordinary English reader of this article the connexions between the last six of them should be obvious enough—to the thinker himself the other connexions are traceable to personal memories. All that is meant here by "free" is that the tendencies directing the path of association of the ideas in the mind at the time, are less easily discovered. Instead of one main idea (that of the blotting-pad) dominating the flow of thought, the direction was taken over in turn by several subjects—by holidays in Wales, politics, and the solution of the housing problems in this country and elsewhere.

This "free" association occurs whenever there is removed from our minds the dominating influence of

a conscious guiding idea. Freud claims that when this occurs, unconscious directive tendencies take over the function of guiding our thoughts, and that in this way, by "freely associating" from any part of the manifest content of our dream, we can discover the underlying latent material of which it is the representative in our consciousness. In this way we can pass from the manifest to the latent content of the dream.

The transformation of the latent content of the dream into its manifest content is called the *dream-work*. This dream-work is not carried out during the occurrence of the dream, but according to Freud goes on incessantly both in our waking and sleeping life. The dream he compares to a firework which, though its display lasts only for a few seconds, may require many hours for its preparation.

What is the function of this dream-work? It is to distort or transform the latent content into a shape in which it is acceptable to our consciousness. And here we enter upon a part of the theory which can only be inadequately sketched in this short essay. It is well known that the activity of consciousness is always selective, that any thought temporarily in consciousness is simply the apex of a pyramid of memories associated with it. If that thought be allowed to develop, some of those memories will emerge into consciousness, while others will not.

Freud believes that one of the most important functions of consciousness—that which he pictorially terms the censorship—is to shield the mind as far as possible from experiences which would be unacceptable to it. In waking life the function of this censorship is usually to repress certain thoughts and desires, the dim premonitory shadows cast by the coming events being sufficient to ensure a refusal to admit them to consciousness. In sleep, however, the vigilance of the censorship being relaxed, the forbidden thoughts—banned because of their painful, immoral, or ugly nature—may clamour for admittance. The dream, according to Freud, is a compromise by means of which these thoughts or desires are allowed to enter consciousness, but in a disguised form. This distortion allows them to pass the relaxed censorship, and at the same time permits the sleeper to continue sleeping: for, Freud believes, had the banned material entered the sleep consciousness in its undisguised form, it would probably have wakened the sleeper in the form of a fear-dream. According to this theory, then, the dream is a preserver, not a disturber, of sleep. The sole exception occurs in the case of the fear-dream.

The processes of the dream-work which Freud has described are of intense interest to psychologists, for even if his theory of their function prove to be incorrect or inadequate, there appears to be ample evidence confirming the accuracy of his description of them. The evidence, indeed, makes it extremely probable that these processes are active, not only in fashioning dreams, but in the work of the waking consciousness of creative imagination, of literature, poetry, and art, the relation of which to the dream many before Freud have already suspected, though none have discovered or explained.

In the dreams of ordinary people, the scenery and the actors are usually fashioned out of visual images, of "pictures in the mind's eye." It is therefore natural that the dream should be essentially symbolic. But, according to this theory, not only may each person or thing in a dream, but any part of them, any dream-word heard or seen, be symbolic of a whole mass of meaning, which is represented by this complex symbol or *condensation*.

Thus in one of the writer's dreams which was analysed in detail,[1] the stage and scenery proved to be composed of two city squares, four restaurants, two lantern-screens, two laboratories, and two manuscript papers, while even the speech heard was a condensation of two such sentences. Moreover, each of these visual symbols represented extremely rich meanings in the dreamer's life, all of which were strictly relevant to the theme of the dream—the temptation to break a promise already given. Even in every-day life, however, symbolism often exhibits condensation, as anyone can see who cares to examine the badge of the Royal Army Medical Corps, or the Union Jack.

The next process of the dream-work, that of *Displacement*, follows inevitably from symbolism and condensation. To employ once more our example of the Member of Parliament, there must be many Members of the present Coalition Government who act as symbols for a very closely packed condensation of the heterogeneous desires of their constituents. It therefore comes about that some of those desires are not fully represented by the subsequent behaviour of the person who was elected to represent them. So it is with the dream; the formation of a compromise-symbol will inevitably involve a displacement of the relative importance of the several desires represented by it, and therefore the part of the manifest dream which appears to be most important for the dreamer will, on examination of the latent content, often prove to be less so. Freud, however, regards such displacement (together with other mechanisms which cannot be discussed in this short article) as further devices to evade the censorship of consciousness.

What, then, is Freud's view of the *meaning* of the dream? It is that the dream is the disguised fulfilment of a wish, which, being unacceptable to the censorship of consciousness, has been repressed into unconsciousness. It is no part of this essay to criticize this inter-

[1] *British Journal of Psychology*, 1914, vol. vi, pp. 292–302.

pretation of the dream's function. The meaning which Freud attaches to the word "wish" is vastly wider than that which it bears for the average reader; or for the average psychologist. But there is steadily growing a mass of material which supports the belief that, if Freud's theory be broadened to include as the inciters of dreams, besides unfulfilled (as well as repressed) wishes, fear, ambitions, remorse, revenge—in fact, any powerful emotional experience behind which lies the driving force of the fundamental instincts—it provides us with an explanation of many otherwise inexplicable dreams.

A dream of Dr. Bernard Hart's [1] shows clearly how a constellation of ideas or "complex," unacceptable to the personality in waking life, may manifest itself in the sleep-consciousness:

"A colleague who occupies a post senior to me upon the staff of —— recently applied for an appointment at another institution. His success would have meant my promotion—but he happens to be one of my greatest friends, and I should certainly resent the suggestion that his departure could occasion me anything but genuine sorrow. Nevertheless I dreamt this dream: He and I were endeavouring to write in an inconceivably small room. The space was so cramped that the movements of one constantly interfered with those of the other. A quarrel resulted, and I had the satisfaction of finally pushing my colleague and friend outside the door. In other words, the complex whose existence I would not acknowledge in the waking state managed to express itself in a symbolical form during sleep."

We cannot close this essay without referring to the views of Dr. C. G. Jung, who, beginning as Freud's pupil, has now diverged from his former teacher in several directions. He believes that Freud has given us only a partial explanation of the dream, in that, looking into the past, he has traced the dream back to the memories which compose it. But to this retrospective interpretation he would add a prospective one: that the dream represents an attempt by the mind to adjust itself to the requirements of the present or of the immediate future; that if one understood a person's dreams, one would know not only his past, but also how he intended to deal with his present, and thereby influence his future.

Part of a dream related by a friend of the writer's may illustrate this:

"From the bank of a rapidly-flowing river he rowed himself into mid-stream. A friend on the bank thought it dangerous, but the dreamer knew that what he was doing was right, and woke up saying a phrase from the Bible, which was then forgotten."

On analysis the river, the friend, and the scenery of the dream were all accounted for in terms of his past experiences. Before going to sleep he had read of a person who, having lived an uneventful life, dreamt that she was surrounded by stagnant water. The day before the dream he had joined the staff of a modern hospital for psychotherapy,[1] and had remarked to a friend that life there seemed to pass at ten times the rate that it had done in his lonely private practice, and that here, as of old, the doctor's functions seem to be merged with those of the priest; for, "Here," he said, "it is possible to save souls." And at this point in the analysis there flashed into consciousness the Scriptural phrase which he had uttered on awaking. It was "fishers of men."

Of such a dream it seems undoubtedly true to say that, whatever it may derive from the dreamer's past, it undoubtedly illuminates his conception of his present and his future.

To regard psychology as the mere description of conscious states is to pay attention only to the surface of experience. And in the modern exploration of the depths of the mind, no light has proved more penetrating than that which comes from Freud's pioneer discoveries. By the analysis of dreams, and by similar analytical methods applied to symptoms, it has already been possible to discover the hidden causes of many nervous and mental disorders. The value of Freud's work to medicine, however, must not blind us to its importance for general psychology. For it has already altered the whole outlook, and probably the whole future, of this study.

[1] *Journal of Mental Science*, 1910, vol. lvi, p. 443.

[1] That is, the psychological treatment of mental cases.

BOOKS SUGGESTED FOR FURTHER READING

On Dreams, by S. Freud. (London.)
"Freud's Theory of Dreams" in *Papers on Psycho-analysis*, by Ernest Jones. (London, 1918.)
The Meaning of Dreams, by I. H. Coriat. (London.)
Dreams and Primitive Culture, by W. H. R. Rivers. (London, 1918.)
Dream Psychology, by Maurice Nicoll. (Oxford.)

The British Academy, at the invitation of and in conjunction with the Palestine Exploration Fund, and with the concurrence of the Foreign Office, have appointed a strong Committee for the purpose of establishing a permanent British School of Archæology at Jerusalem. The objects of the School will be: (1) To facilitate the researches of scholars; (2) To provide instruction and guidance for students; (3) To train archæological excavators and administrators. The School will assist in every possible way the excavations and explorations of the Palestine Exploration Fund. The scope of periods and subjects of study will be unrestricted, ranging from the Stone Age and the early civilisations of Amorites and Canaanites through all the history of Palestine and Syria, and their relations with the nations around them, down through the Græco-Roman Age to the Arab Conquest, the Crusades, and the later Mohammedan period.

Discovery and Education

By A. L. Smith, M.A.

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THE war has presented us with three discoveries in the sphere of education. We have found in the first place that war could be a great education, and this in the most literal sense; that war training and war itself could produce not merely improvement in physique and strengthening of character, but also could and often did—and this was the surprise—develop the actual powers of the mind. This should not have been a surprise; for, after all, education is only the development of the power of thinking, and as more than one young soldier has found, "You have to do a lot of thinking in the trenches."

Long ago, in the infancy of democracy, it was said, "Now we must educate our masters." Now that the people are very manifestly our masters, the need is still more manifest. "What! a burning desire for education, true education, that is a love of knowledge for its own sake or for the still higher sake of fitting the student to serve his country! Can there be such a widespread passion now among the masses?" This question has been so put by a sceptical journalist. He may receive some enlightenment if he consults the evidence in the *Report* just issued by the Committee on Adult Education (Cmd. 321), or if he inquires into the experiment of the Army Camps in the last two years. This has been the second discovery. But (to quote the journalistic critic again), assuming the desire, is there the capability among the masses? Here, again, the answer comes from practical experience, experience summarized in the *Report*. It is true that the thoughtful and studious, who will naturally lead the opinions of their fellows in mine, factory, or shop, can never be more than a few thousands. But these thousands are a leaven; they are more in number than could have been guessed; that number is capable of rapid and immediate expansion; and outside these more select students, there is a far greater circle of adult men and women capable of far more than we imagined in the way of intellectual interests. Till this war we undervalued the military value of the rank and file of our people because we did not realize their moral capacity. Do not let us go on undervaluing their intellectual capacity; for the discovery of this has been the third educational discovery of the war.

The Government Committee on Adult Education, which has been sitting for two years and has just produced its *Final Report* (Cmd. 321), found that these three facts were implicit in the experience we already had before us. It found also that Adult Education was not a mere phrase or fad, or even a superfluous luxury, but an absolute necessary of the nation's future social and political life. In this we might also learn from the enemy. The Germans pronounced us a profoundly uneducated people who knew no foreign languages, worked short hours, substituted "good form" for efficiency, depreciated teachers, had no respect for knowledge, were given over to sport and games, holidays and "week-ends," not to mention strikes and drink. The Germans used to declare that it was their schoolmasters that won them the wars of 1864, 1866, 1870; and they certainly showed in this war what formidable strength can be produced by a universal, scientific, systematic instruction resulting in an extraordinary unanimity of national aim, and an undeniable capacity of sacrifice for an ideal.

True, the German machine lacked variety, buoyancy, and individual initiative, qualities which only grow in an atmosphere of freedom. What we have to learn is how to combine freedom and individual initiative with a more efficient system and organization. Only thus can we face our present problems, which all come back to better education as their basis and demand. Thus world-peace depends in the last resort on the proportion of intelligent citizens, British and American, that appreciate the danger, and are willing to meet some corresponding obligation. Or, if we take the Imperial position, it has to be readjusted to two opposing facts, the determination of the Dominions to have a say in the future before going to war, and their equal determination to submit to no diminution of their own autonomy. How can these be reconciled but by a public opinion educated out of its mistrust of the term Empire, and educated up to the vast potentialities implied in a World Commonwealth?

Then there are our home problems. Is the State to buy up mines, railways, "the trade"? Can Democracy get its will really represented, or must it have recourse to "direct action"? How is "Labour Unrest" to be turned into industrial harmony without a better understanding on each side? Is the tremendous question of women's standing as industrial competitors against men, with its incalculable results on family life and sexual morality, to be settled by an uneducated generation? Or, to deal honestly yet wisely with the two cankers of our society, drink and prostitution, can we trust to anything but the education of that social conscience which is now so callous? The politicians will not take up these problems till there is a public demand, and that means a more enlightened public—in other words, the extension of a true education into adult life.

The first step is to attack the obstacles which now hamper adult education, such as excessive hours of labour, fatigue,—whether due to monotony or to

unduly exhausting work—insecurity of employment, lack of holidays. On all these conditions the workers themselves are coming to be acutely conscious. They realize that modern industry tends to become more and more mechanical, that it provides less educational interest in the work itself, and offers little opportunity to satisfy intellectual, social, or artistic impulses. They demand " industrial control " on the ground that industrial democracy is as essential to individual freedom as is political democracy. Present social conditions also stand in the way. Inadequate housing, (nearly half the population living more than one to a room), squalid surroundings, low wages, especially in rural districts, lack of village halls or public rooms—all these create a vicious circle to which the women are tied down even more than the men. These conditions call for reform on moral and social grounds; while it is obvious that they are vicious also on economic grounds. For no one can doubt that we are at a turning-point in our national history. A new era has come upon us. We cannot stand still. We cannot return to the old ways, the old abuses, the old stupidities. As with our international relations, so with the relations of classes and individuals inside our own nation; if they do not henceforth get better, they must needs get worse, and that means moving towards an abyss. It is in our power to make the new era one of such progress as to repay us even for the immeasurable cost, the price in lives lost, in manhood crippled, and in homes desolated.

Only by rising to the height of our enlarged vision of social duty, can we do justice to the spirit generated in our people by the long effort of common aspiration and common suffering. To allow this spirit to die away unused would be a waste compared to which the material waste of the war would be a little thing; it would be a national sin, unpardonable in the eyes of our posterity. We stand at the bar of history for judgment, and we shall be judged by the use we make of this unique opportunity. It is unique in many ways, most of all in the fact that the public not only has its conscience aroused and its heart stirred, but also has its mind open and receptive of new ideas to an unprecedented degree.

It is not the lack of goodwill that is to be feared. But goodwill without mental effort, without intelligent provision, is worse than ineffectual; it is a moral opiate. The real lack in our national history has been the lack of bold and clear thinking. We have been well-meaning, we have had good principles; where we have failed is in the courage and foresight to carry out our principles into our corporate life.

This corporate life itself has only been made visible and real to us (as on a fiery background) by the glow and illumination of the war. We have been made conscious that we are heirs to a majestic inheritance, and that we have corresponding obligations. We have awakened to the splendid qualities that were latent in our people, the rank and file of the common people who before this war were often adjudged to be decadent, to have lost their patriotism, their religious faith, and their response to leadership; we were even told they were physically degenerate. Now we see what potentialities lie in these people, and what a charge lies upon us to give to these powers free-play. There is stirring through the whole country a sense of the duty we owe to our children, and to our grandchildren, to save them, not only from the repetition of such a world-war and from the burdens of a crushing militarism, but to save them also from the obvious peril of civil dissension at home. We owe it also to our own dead that they shall not have died in vain, but that their sacrifice shall prove to have created a better England for the future generation.

Though education in this sense was so vital a need, yet the ordinary Englishman had never realized it. He regarded it as a subject inherently dull and dry, because it was too " bookish," too much absorbed in the technique and mechanics of the art. It was " finished " at about eighteen. Indeed, for the mass of the population education finished before fourteen, and naturally education which ceased then was forgotten before eighteen. The mass of the eighteen-year-old recruits were found unable to write a simple letter, unable to do a simple sum, and hardly able to read even the simplest book; but with the new Education Act, adult education starts at a new level, and also demands wholly new methods. It must begin with the existing avocations and interests of the youth, to show the reasons that underlie his daily work, the relation of his work to that of others, and its place in the service of the nation and of the world. In the Army Camps from February 1917, recruits of eighteen from the woollen district might be seen learning where the different kinds of wool come from, what has been the history of the industry, what are the qualities which make wool the best clothing, what mechanical means are used on it, and what principles are embodied in the machines in wool-factories; and so in other cases we have to begin not with abstractions but with the concrete objects, and work back to the *rationale* of them.

To see all this coming out of the army was like a modern version of Samson's riddle: " Out of the eater came forth meat! " Mr. Fisher, indeed, has said, with one of his happy audacities, that it is a new departure as epoch-making as was gunpowder in military history. For a whole group of discoveries are involved in it; that a modern army may be the means of training a whole population in that physical efficiency and mental

alertness which are now seen to be, more than mechanical drill and discipline, the essential things in modern warfare; that part of this training may make the recruit a better man at his own future craft, more of a "handy man," and a more efficient military unit; that alongside there may be, as there should be, a training in the elements of citizenship so that the recruit gets at least some idea, (*a*) what his nation is, and what it stands for in its past history and literature, and what is its place among the other nations of the modern world; (*b*) what are his duties to it, from the elementary duties of sharing in its defence and submitting to its laws, up to the duty of helping to maintain and even to elevate its standards and ideals; (*c*) what are the economic, political and international conditions on which his nation's efficiency and well-being depend, its relation to the other constituent parts of the Commonwealth of British nations called the Empire, and the degree to which it can now or in the future enter into closer relations with other civilized nations for the just treatment of less developed races, for the furtherance of international co-operation in science, medicine, law, commerce, arts, and for the increasing establishment of world-peace.

A future age surely will wonder that modern nations, which had in their conscript armies the whole of their youth during those plastic years eighteen to twenty-one, made no use of this unrivalled educational opportunity, even from the narrow militarist point of view.

It is not commonly realized what a great mass of efforts went on through the nineteenth century to build up some system of higher education suitable to the needs of adult men and women. These efforts drew their inspiration from different sources—religion, science, politics, economics; many movements contributed, such as Chartism, Co-operation, Trades Unionism. But all the earlier efforts, till after 1870, were hampered by the absence of a general elementary education. Even then there was still the gap of the years from fourteen to eighteen; now that this is to be filled up, there will be great expansion. Already the standard of the work done, according to the report of the Board of Education Special Inspectors, among the best students, compares favourably with the best academical work; they are fit to read for the Oxford Diploma in Economics, and would obtain it without difficulty. Is it not remarkable to find such results among students who have had no education since fourteen, who at first can only read a book with excessive slowness, and can hardly put down their thoughts on paper at all? Is it not an interesting discovery to find that the school of life can do as much for mental training as a definite college course? These most recent efforts have all sprung from the workers themselves, and the Workers' Educational Association, thirteen years old, now comprises 219 branches, 2,525 affiliated societies, and over 17,000 members. The highest point reached is in the Tutorial Classes, in which each student pledges himself for three years; the total number of such students in the year before the war was 3,234. These classes are already showing signs of rapid development. In one industrial district with an adult population of 400,000, the number of students attending Tutorial Classes, One-year Classes, and Extension Classes was over 7,000. There are institutions such as the Working Men's College, with its 3,939 students. The total numbers included in some form of adult education consist of an appreciable fraction of the population of the country; and the movement is only in its infancy.

There are important lessons to be learnt from these facts. The first is that real education can often be begun again in adult life. The next is that such education should start from the facts which are already part of the learner's familiar experience. The third lesson is that this method, by its freshness and actuality, supplies a new inspiration to the teachers themselves. The fourth lesson is that manual work itself may be so treated as to be a vehicle both of culture and of mental training. The defects in adult education as it stands at present are that too often it is discontinuous; there is apt to be undue reliance on lectures, and not enough class work and personal effort, not enough personal criticism and individual tuition; the teachers are too few, and hence get overworked; and there is not an adequate supply of books. But these defects are all curable, and that not at great cost; and adult education, like other forms of higher education, can never be completely self-supporting. It must always depend largely on voluntary effort and spontaneous enthusiasm, particularly now in its pioneer days; but it ought not to be asked to live wholly on this its precious capital. The Trade Unions and the Co-operators ought to help more than they do, but so too should the Universities and, above all, the State.

The Theory of Relativity. By H. L. Brose. (Blackwell, 1*s*. 6*d*. net.)

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References are given to the standard works on the subject, so that this pamphlet may well serve as a starting-off point for interested readers.

Pioneers of Progress: Herschel, by HECTOR MACPHERSON; *Joseph Priestley*, by D. H. PEACOCK. (S.P.C.K., each, 1*s*. net paper; 2*s*. net cloth.)

Concise and straightforward descriptions of the lives of these two pioneers.

The Conference of Paris

By J. W. Headlam-Morley

By the time that these words appear in print, it is probable that the Treaty of Peace with Germany will have been ratified, and within a few weeks the Congress of Paris will have come to an end. It will take its place in the history books, with the Congress of Utrecht and the Congress of Vienna, as one of the great landmarks in European history, and it may be interesting to take this opportunity of considering its work and its achievement from the point of view of the student and teacher of history.

It is natural to compare the Congress of Paris with the Congress of Vienna, and I fear that, in the minds of many, the result of the comparison has been, as it was expressed to me by a great scholar: "I think we are all beginning to think better of the Congress of Vienna." I am quite sure that those historians who took part in the Conference of Paris—and there were several—will be, shall we say, a little less severe when they have brought practical experience to the criticism of the deeds of our predecessors. But if we are to make the comparison, let us recognize at once that Paris had difficulties to meet from which Vienna was freed.

In the first place let us note that, as compared with the Congress of Vienna, that of Paris had imposed upon it a double task. In 1814 there were two things to be done, first to settle the terms of peace between the Great Alliance and France, and secondly to settle the numerous questions which arose as to the assignation of that territory which, after being surrendered by France, was left derelict. These two stages were clearly separated. Peace was made with France at Paris within a few weeks of the termination of the war, and it was possible, therefore, for the Powers of Europe to apply themselves in comparative leisure to the other problems. In 1919 a different procedure was adopted; the whole settlement of Europe had to be made under the form of Treaties of Peace, and the settlement between the Allies themselves, a settlement in which inevitably strong differences of opinion must appear, had to be made while the state of war still continued. It is curious to note that this was probably not the original intention; at any rate, throughout a every large part of the Congress, all the papers were headed "Preliminaries of Peace," a style which seemed to indicate that the original intention had been first of all to make general preliminaries of Peace with Germany, and afterwards to proceed to more detailed regulation of minor and secondary points.

Another difficulty arose from this procedure—viz., that direct communication with the enemy Governments was excluded. A study of the text of the treaties will show that they deal, often in great detail, with matters of great complexity; this is especially the case in the chapters dealing with financial and commercial matters. Merely as a matter of procedure, the work would have been much facilitated had it been possible to discuss these matters around the table with the German Delegates; the possibility of this was, however, excluded.

Another result was that there was thrown upon the Conference, not only the task of making peace, but the even more serious task of controlling the affairs of Europe during the process. What had to be done for the temporary administration of those districts whose ultimate fate had to be determined? Many of these were the subject of acute controversy between our own Allies, and this threw upon the Conference the responsibility of keeping order in these disputed territories, and at times even preventing open hostilities between the Allied States themselves. Let us add to this that the very progress of civilization has added immensely to the complexity of the problems which had to be dealt with. In 1814 there were no railways; in 1914 the problem of transport forced itself upon the attention in two different ways. First of all the daily life of millions of people in Europe depended upon the provision of adequate means of transport, and, secondly, it was impossible to determine the frontiers without taking into consideration the lines of communication. If the frontier had to be drawn between Poland and Germany, or Czecho-Slovakia and Poland, or Italy and Yugo-Slavia, it was necessary so to arrange it, as not only to comply approximately with the nationality of the population, but also so as to insure that there should be no undue interference with the control of the main lines of railroad.

It is therefore little to be wondered that the work thrown upon the Congress was almost beyond human capacity. It was on the Council of Four that the stress of the labours rested, and I wonder sometimes whether those who criticize the result have ever tried to imagine what the extent of the labours and the measure of the responsibility was, which attached to these men. Day by day, and week by week, they had two meetings, one in the morning and one in the afternoon, at which there would be brought up to them for their final decision, now the question of the frontiers between Poland and Germany, or Czecho-Slovakia and Hungary, and the future of the Banat, or Teschen, or Klagenfurt, or Danzig, and then, with scarcely a moment's pause, complicated questions as to the treatment of enemy debts, with the determination as to the rate of exchange at which they would be fixed, what was the extent of the reparation which

could be imposed upon Germany, and in what form and by what machinery it should be exacted, the determination as to international control of the waterways of Europe, the conditions which should be attached to the recognition of new States, such as Poland or Czecho-Slovakia, the innumerable questions which arose out of the liquidation of the Austro-Hungarian Monarchy; and all the time there pressed for immediate decision matters of urgent practical policy, such as the attitude that should be adopted towards the claims for autonomy or independence of the Baltic States, the relationship towards the Bolshevik Government in Russia, and the help, if any, which should be given to the forces of Kolchak and Denekin, the method of establishing the control of the Conference over the insurgent populations in East Galicia, and, at the same time, the steps necessary for carrying out the conditions of the Armistice with Germany. To those who look back on the multitude and rapidity with which problems of this kind came up, it may be a matter of surprise, not that from time to time decisions were made which have not commanded universal consent, but that the work was done at all.

But perhaps the most striking difference between Paris and Vienna arose out of the peculiar nature of the terms of the Armistice, in which were specified the general principles in accordance with which the peace was to be made. Germany had laid down her arms and the Allies had agreed to an armistice on the condition that the ultimate peace should be in accordance with certain principles which had been stated by President Wilson. These are generally referred to as the "Fourteen Points," but it is worth while remembering that they were, in fact, not limited to the fourteen points specified in his speech of January 1918; there were also included in the correspondence preceding the Armistice a reference to any later statements that he made. In fact, the other statements which he made comprised four other lists of points placed in a categorical form, and made in subsequent speeches or official messages. It has been stated that the Conference completely ignored the Fourteen Points, that they were not considered. This can be emphatically denied. Each individual can, of course, only speak as to his own personal experience, and this is necessarily limited to those parts of the discussions with which he was immediately concerned. I may at least be allowed to record my own experience. It is that throughout the discussions there was constantly present to the minds of those who took part in them, and frequent reference made to, the Principles of the Peace, and I can affirm, on immediate and personal knowledge, that in the Council of Four itself the decision on matters of the highest importance was determined by explicit reference to the Fourteen Points—e.g. a decision favourable to the Allies, and for which there were many grounds of expediency, would be rejected solely because it could not be reconciled with the pledges which had been given. But the Principles by which the work had to be guided had not been expressed in a manner which made their translation into precise legal form easy; to a large extent they were general conceptions, aspirations, exhortations, and some of them were not easy to reconcile with one another. Let us take one of the four points in President Wilson's address to Congress of February 11, 1918: "All well-defined national aspirations shall be accorded the utmost satisfaction that can be accorded them without introducing new, or perpetuating old, elements of discord and antagonism, that would be likely in time to break the peace of Europe and consequently of the world"; and another, in the same speech: "Each part of the final settlement must be based upon the essential justice of that particular case, and upon such adjustments as are most likely to bring a peace that will be permanent." To these dicta all might give assent, but the application is not without difficulty. How are we to accord utmost satisfaction to the well-defined national aspirations of the Poles or the Czechs or the Yugo-Slavs, without introducing new or perpetuating old elements of discord and antagonism? And how are we to define what is the well-defined national aspiration? Are the claims of the Ruthenians of East Galicia, or the Wendish inhabitants of Lusatia, or the Lems of the Carpathians, to receive recognition under this formula? And how are we to balance the historic claims of the modern representatives of the old Polish and Bohemian State against the rival claims of ethnographic frontiers? East Prussia had been Polish land to the time of the Partitions; then it became Prussian, and since then there has been a large German infiltration of population. If we assign this territory to Poland, East Prussia will be separated from the rest of Germany; if we assign it to Germany, Poland will be cut off from the sea, and a large Polish population continue under German subjection. Where is justice, which we all seek, to be found? The settlement with Germany has been widely criticized on the ground that it is incompatible with the Fourteen Points; I venture to think that, on territorial points, the more impartial judgment of the future will be that, in face of problems of unexampled difficulty, the greatest effort was used to find a settlement which would be in accordance with the principles of the Treaty. No purely and undoubtedly German territory is to be separated from Germany, and where there was a reasonable doubt as to the affinities and wishes of the population, it has been determined that they themselves shall be consulted as to their future allegiance, as in Upper Silesia or in the district of Mazuria.

It is the first time that in a great European settlement the population of doubtful territories have had the opportunity of giving their own vote. This principle had, indeed, been adopted at the time of the French Revolution, and received its most emphatic sanction in the time of Napoleon III, first in the creation of the United Kingdom of Italy, and secondly in the transference of Nice and Savoy to France. The conception of the plebiscite is a principle which it is easy to accept, but the application of it presents great difficulties and dangers, and it was not unnatural that the Conference should use it only in those cases where it was absolutely inevitable; for a plebiscite means prolonged uncertainty, the continuation of national animosity and allied occupation.

Sound-Ranging in War Time

By A. S. Russell

SOUND-RANGERS were a body of men who, in the late war, spent their time and energy in locating hostile batteries accurately, in estimating the number of guns or howitzers in such batteries, in ascertaining the calibre of these guns, and, on occasion, in assisting certain portions of the Royal Regiment of Artillery in "strafing them to blazes." This they did, these sound-rangers, not by guess-work or intuition, or by bluff; they had a system, and the whole system, method, apparatus and procedure goes by the name of Sound-Ranging.

At the bottom of the whole matter is the fact that sound travels, not quickly like light or electricity, but at a comparatively leisurely pace—namely, about 370 yards a second in air at ordinary temperatures. Suppose, now, that a loud noise as, for example, an explosion, occurred at some particular spot in South London, the report would reach Londoners at various times after the explosion had really occurred, depending upon their distance from the place where the sound came from—the sound travelling in every direction at equal rate, at about 370 yards per second, neglecting the (very slight) influence of the wind. If an observer on the Monument heard the explosion at exactly the same time as one on the tower of Westminster Cathedral, it is obvious that, wherever the sound originated, it did so at a place that is equidistant from these places. If, however, we suppose the observer on Westminster Cathedral heard the sound exactly one second before

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BELL'S LIST

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the observer on the Monument, then it follows that the origin of sound must be at some point which is about 370 yards nearer the former place than the latter.

The number of places in London which are this distance nearer to Westminster Cathedral than to the Monument is legion, but, if we mark all such points on an accurate large-scale map, it is found they all lie on one curve; and, further, if the place where the sound began is more than three miles away both from Westminster and the Monument, the curve may be taken as a straight line without any appreciable error. This simplifies matters enormously. With two points of observation, therefore, knowing exactly how soon the sound arrives at one before the other, we have information enabling us to draw on a map a straight line, some point of which is the place we want to find out.

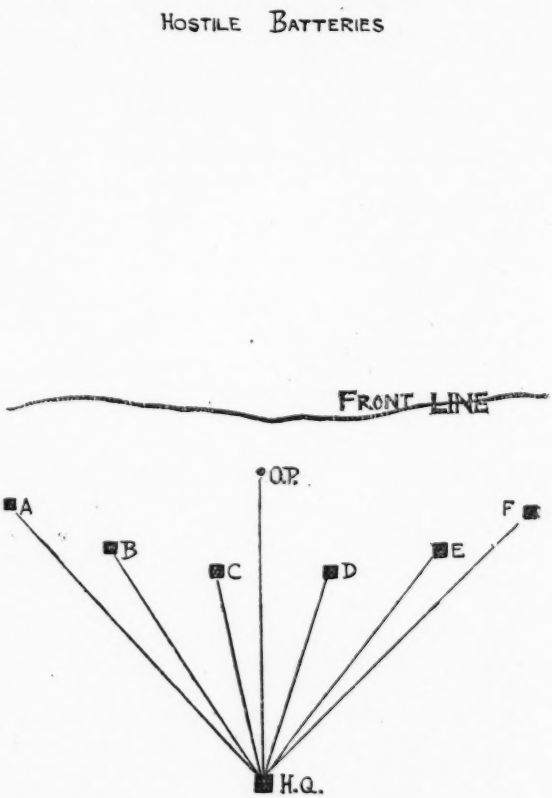
We shall now suppose we have a third observer, and we shall place him in the window of a certain house in Chelsea. He hears the noise of the explosion, we shall suppose, exactly half a second after the man on Westminster Cathedral. If follows that the source of sound must be about 185 yards farther from him than from the man at Westminster. With this fact before us we are enabled to draw a second line on our large-scale map of London, every point of which is 185 yards nearer Westminster Cathedral than the house in Chelsea. This line intersects the first one somewhere. That somewhere is the only point which is common to both lines, it is the only point in South London which is *both* 370 yards nearer Westminster Cathedral than the Monument, and 185 yards nearer the latter than the house we selected in Chelsea. That is the point where the sound originated.

To locate a sound, therefore, we require to get possession of such facts as will enable us to plot on a map at least two curves. For this we require three places of observation. If we had six places of observation we should obtain data for five curves, and if these all intersected at one point, as in general they would, we should be inclined to feel surer of the point we were trying to locate, than if we had merely an intersection of two lines. Similarly, if we had a hundred places of observation, and measured the differences in time between a sound arriving at these, we should be enabled to draw ninety-nine curves. Accuracy in locating sounds, however, does not depend upon having a host of observation-stations, but, other things being equal, upon having these stations as widely separated as possible.

When the French Army (they were the pioneers in this work) discovered that this simple scientific principle might be used with advantage in locating hostile batteries, they commenced experiments. This was done in October of 1914, when it looked as though the fighting in France was going to settle down to trench warfare. Their work was so successful and promising that the British took it up, and a year later an experimental sound-ranging section set to work at Kemmel Hill, just south of the Ypres Salient. This unit developed the work in its own way, both scientifically and tactically, and in 1916 each army of the Expeditionary Force on the Western Front had two of these units assisting the Heavy Artillery. In 1917 and 1918 there were more than thirty sections working on the Western Front, and a few in Salonika and in Palestine also.

The original officers were men trained in physics who happened to be serving with their infantry or artillery units in France or at home in 1914-15. Sound-ranging, therefore, never ran the risk of becoming an ultra-scientific series of pretty experiments, of interest to research workers alone. It developed into a system of real tactical value.

A sound-ranging section consisted of four officers



and about forty men. The disposition of their headquarters, and their sound detectors, with regard to the front line, is shown in the figure. The personnel lived

at the spot H.Q. about four to six thousand yards from the line. Here the whole of the apparatus for locating the hostile batteries was kept except the six sound-detectors, or, as they are also called, the microphones. One of these instruments was placed at each of the points A, B, C, D, E, and F, which points were usually from three to five thousand yards behind the front line. Each of these points was carefully surveyed so that its exact position on the map was known. Usually it was arranged that the six points were at intervals of about a mile, and lay on a circle, the centre of which was inside the enemy's lines at about the average distance back of the enemy's heavy artillery. This was done merely for convenience, and is not a necessary element in locating the batteries. The sound-detectors at each of these six points were connected up with the recording apparatus at H.Q., by wires, just as though they were telephones. It was found that it was much better in every way to detect the report of a German gun with an apparatus than by the ear of a man. The very instant the sound was heard at B, for example, the fact was instantaneously communicated along the wires to H.Q., where it was recorded. If a man, however, was observing, a time of one-twentieth to a fifth of a second would elapse between his hearing the sound and his pressing a button to record it, depending upon his experience and his natural quickness. This is a very interesting fact in experimental psychology, but in sound-ranging it led to inaccuracies. A sound-detector, specially designed by one of the officers, was therefore used instead.

There were observers, however, at the observation post, marked O.P. Their duty was to listen, and to observe. When a German gun or howitzer fired, one of them pressed a button as soon as he heard the report. This had the effect of starting up the whole of the recording apparatus at H.Q. A few seconds later the report of the gun would be heard by the microphone which was nearest to the battery firing, then by the second nearest, and so on till all had heard it. When the observer considered that the sound had passed over all the detectors, he ceased pressing his button, and so stopped the recording apparatus working. This remained quiescent until the German battery fired again. The observer next telephoned to H.Q., in cheerful tones, the direction from which the sound of the enemy gun had come, his idea of the size of the shell, and, when he could see what the enemy were trying to hit, the approximate location of the target. All this information is very valuable to the men at H.Q., whose job it is to work out the location accurately.

I have said the forward observer at O.P. controls the recording apparatus at H.Q. This observer is sufficiently in front of the line of detectors to hear most

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gun reports two or three seconds before any detector can. During this interval he has started up the apparatus, and it is running merrily and is ready to record. As each detector gets the sound, a little wire at H.Q. gives a jerk, and the moment of this jerk is recorded by photographing these wires on a moving film. Everything is so arranged that simultaneously the time intervals between these jerks are recorded on the same film accurately to one-hundredth part of a second.

When the apparatus stops, the film is developed and fixed in about ten seconds, and handed to a computer, who obtains from it the time intervals between the signals. These intervals are, of course, the differences in time between the sound of the gun arriving at the six detectors. These give him five time differences—namely, the differences between the sound arriving at A and B, B and C, C and D, D and E, and E and F. From these five differences, after correcting for temperature and wind, he gets his five lines, from the five lines his intersection on the map, and the point of this intersection very approximately is the enemy gun. This location is at once telephoned to the Heavy Artillery, who immediately take such action as they consider fit. The sound-ranger's work is diagnosis. He says where the offending battery is, whether or not it is very active, what place it is trying to hit, and so forth. Our artillery supply the remedy.

The accuracy of sound-ranging locations could be tested in several ways. The results could be compared with those obtained at the same time by other sources, as, for example, by the observations of R.F.C. pilots during the day, and of "flash-spotters" by night. Secondly, the locations could be checked by comparison with air photographs. This was most easily done when some sign of an emplacement or of a battery position was visible on the photograph. The third and most convincing check was an examination of the former German battery positions after an advance had been made into their territory. Fifty yards was about the mean error made in a sound-ranging location under normal circumstances.

A sound-ranger's life on a quiet front was a happy one. On such fronts there was little enemy firing, and the enemy did not move his batteries more than he could help. The sound-ranging locations, collated with evidence from air-photos and flashes at night, led in general to the discovery of the exact positions of the batteries.

Very rapidly the special stunts, habits, and even idiosyncrasies of each battery were known. They became quite old friends. Such friends had a rough time of it. As soon as they had opened fire, and in due course been located, they were fired on by our artillery. Anyone who knows about artillery firing will appreciate the difficulty and expense of "knocking-out" a hostile battery, but it was comparatively an easy matter to "silence" or "neutralize" it—that is to say, in plain English, to make it stop.

On such fronts, in addition to his normal work of locating batteries, the sound-ranger could also "observe" for the Artillery, if by "observe" we mean here directing fire, not by looking at where the round fell, but by listening for its burst. A great deal of this work was done for our Heavy Artillery in 1917 and 1918 on all except the extremely noisy or battle fronts, and much valuable aid was thereby given them. A numerical example will help to make clear the method by which this was done. Suppose a German battery fired from such a position that its report arrived at the detector at A first, then half a second later at B, then one second later than that at C, one and a half seconds later than that at D, two seconds later than that at E, and two and a half seconds later than that at F. Suppose next that from these time differences the sound-ranging section has located the position of the offending gun. One of our own batteries, a 6-inch, an 8-inch, or a 9·2-inch howitzer battery, was then called up from H.Q., and asked to fire on the located point. In due course the round was fired and exploded in enemy territory. This explosion was now located just as though it were a gun report. Now, if this noise arrived at B after A by exactly half a second, at C after B by exactly one second, at D after C by one and a half seconds, and so on, then it is obvious that this sound must have come from exactly the spot where the gun report originated. In plainer terms, the hostile battery has suffered a direct hit. This, of course, would be a rare occurrence with the first round. Ordinarily the time intervals recorded for the burst would differ somewhat from those of the German gun, but knowing these differences, by means of a "gadget," the computer could tell at once how far over or short of the target, or how far right or left of it, the round fell. The correction was sent to the gunner, and the British gun continued firing and being corrected till the record of the burst coincided with, or approached as nearly as possible to, the original record of the hostile gun.

This method of ranging was most conveniently used when the usual kind of observation, whether by aeroplane or ground observer, was impossible, as, for instance, at night or at dawn, or on dull, foggy afternoons. None the less it could be extremely accurate work, and this accuracy could be tested by photographing from the air, subsequent to the shoot, the neighbourhood of the battery fired on, and comparing the positions of the shell craters with the points where the sound-ranger said the rounds fell.

On busy, noisy, and battle fronts, the work of the sound-ranger was more difficult, partly because of the

row due to our own artillery, and partly to the cutting of the wires connecting the sound-detectors with Headquarters. He had to do his best in difficult circumstances, get his wires mended under fire, wait for lulls or night-time, and work hard then. It is a great mistake, however, to conclude that even on busy fronts the guns of both sides were firing all the time. Conditions were not always adverse, and by experience, hard work and resource, the location of the batteries by sound could be effected.

Like most scientific work used for tactical purposes in the war, sound-ranging, both as a strictly scientific study of the vagaries of sound, and as an instrument for helping on our side, showed steady improvement in method and in utility right up to the Armistice. This was due to the splendid co-operation between the powers that be and the experimental sound-rangers at General Headquarters, and between the Heavy Artillery and the routine sound-rangers up the line.

NOTE.—For further information on this subject see *Nature*, November 13, 1919, p. 278.

Spitsbergen

By R. N. Rudmose Brown, D.Sc.

Lecturer in Geography in the University of Sheffield

ALTHOUGH the discovery of Spitsbergen is generally attributed to the Dutch in 1596, it is quite probable that the Norsemen knew it earlier under the name of Svalbard. Possibly, also, Russians knew it before the Dutch discovery. Early in the seventeenth century British, Dutch and Danish walrus hunters and whalers began to visit it in great numbers. When they fell off owing to the partial extinction of their prey, Russian trappers from the White Sea began the habit of wintering in Spitsbergen in search of bears, foxes, and reindeer. At a later date Norwegians supplanted the Russians and almost exterminated the game. However, in spite of all this activity and the visits of many exploring expeditions—British, Swedish, Russian, and later Norwegian—much of the country is still unexplored, and comparatively little, even of the coasts, is accurately mapped.

There is still some winter hunting in Spitsbergen, but at present the country is attracting attention on account of its mineral wealth. The first coal bed was found about 300 years ago; since then many other seams have been discovered, but before this century no attempts at coal-mining were made. Whalers and hunters occasionally used the coal from time to time,

[*Continued on p. 24*

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and exploring vessels, short of fuel, have replenished their supplies on some occasions. Coal was not the first mineral to bring miners to Spitsbergen. As long ago as 1872 an unsuccessful attempt was made to dig phosphates by a Swedish company. It was, however, a British company which began coal-mining in 1904. Their mine was near the mouth of Advent Bay, and there grew the first timber village in Spitsbergen. For various reasons the mine was abandoned after a few years. In 1904 Americans also came on the scene, purchasing from Norwegian owners an estate in Advent Bay opposite the English mine. Longyear City, as they called their camp, grew in a few years' time to a settlement of several hundred miners living in log houses. It is still the unofficial capital of Spitsbergen, and its wharf in summer is seldom without a steamer loading coal by the wire ropeway from the mine. The success of the Americans brought a host of prospectors to Spitsbergen. They planted their claim boards on every shore, as often as not ignoring previous claimants. In districts where coal was known to occur the claim boards were most frequent, but quite valueless shores had their share of them. No attempt was made to develop most of the estates beyond the construction of a few prospectors' huts. As often as not the so-called "prospectors" were quite unqualified for their task. In those days Spitsbergen was beyond the sovereignty of any nation: no State had the power to enforce its laws. There was no satisfactory system of registering claims, and no court of arbitration or appeal. Anarchy reigned, and each claimant had to watch and protect his own interests, but except for the insecurity of property, the system or want of system worked well enough. The absence of taxes, mining dues, etc., had its advantages.

It was, however, due to the war that Spitsbergen mining really progressed, and incidentally that Spitsbergen ceased to be a no-man's land. During the years of war, development work on British claims was perforce in abeyance, but it made great strides on Norwegian and Swedish estates. This was due to the high cost of coal and its great scarcity in Norway and Sweden. Scandinavians worked with feverish energy to extract as much coal as possible in Spitsbergen before the price of coal fell. The American coal-mine was bought by Norwegians, two new Norwegian mines and a Russian mine were started, and a Swedish mine revived. As soon as the war was over the two British companies owning land were again at work on their estates. One of them last summer not only located a new coal-field and begun its development, but discovered large deposits of good iron-ore on Prince Charles Foreland, the most westerly island of the group. At present five mines in Spitsbergen are exporting coal; this number will soon be increased. The total coal export has risen from 35,000 tons in 1913 to close on 100,000 tons in 1919; in a few years it should be over 250,000 tons. Even this will be insufficient to supply Norwegian ports between Narvik and Vardö, to say nothing of the demands of the Russian ports of Murmansk and Arkhangel.

Although in the Arctic regions, Spitsbergen is really part of Europe. It is only 400 miles from Norway, and 1,300 miles from the Firth of Forth. Spitsbergen —which has an area about equal to that of Scotland— includes one large and a number of smaller islands. The distant Bear Island and Hope Island are generally included. The mainland of Spitsbergen is deeply indented on the west by long, branching fjords: Ice-fjord, Bell Sound, King's Bay, and Smeerenburg Sound are names of frequent occurrence in the long and adventurous story of Spitsbergen. Narrow strips of plain fringe some of the coasts, and are crossed by glaciers flowing to the sea down the valleys of the ranges. For the most part the country is very mountainous, but few peaks rise to more than 3,000 or 4,000 feet. Almost everywhere the surface of the land is rough and rocky, or covered with swamps, but several levels of raised beach around the coasts afford natural highways and building sites of great value in the present phase of Spitsbergen's development.

In winter the temperatures are low, the snow-line descends to sea-level, and the coasts are generally ice-bound, but in summer the conditions are very different. The warm Atlantic drift and the prevailing south-westerly winds not only keep the western coasts open and free from ice from May or June to October, but cause comparatively high temperatures. The result is that the west coasts are easily accessible throughout the summer by ordinary vessels, and all the lower ground is free from snow. The continuous daylight adds to the charm of summer in Spitsbergen. Vegetation is scanty, and there are no trees. Patches of bright-coloured flowers, however, are not infrequent, and mossy bogs are numerous. The animal life includes reindeer and foxes throughout the year, and polar bears in winter when the pack-ice comes south. Bird life is abundant, many of our well-known birds going north to Spitsbergen to breed in summer: but in winter the ptarmigan or some wandering gull are the only birds to be seen. Mosquitoes, the summer plague of Northern Europe, do not occur.

There has never been any native population, but the land is not uninhabitable, as is proved by the fact that this winter over 500 miners are living there in comfort. Longyear City, the largest settlement, has some thirty large houses, comfortably furnished, many with central heating, and all lit by electricity. There are club-rooms, billiard tables, libraries, and even a kinema

theatre, for the miners and engineers. Wireless telegraphy keeps them in touch with the outside world. There is a Norwegian post-office, and a well-stocked shop supplies all reasonable wants. Fresh meat brought from Norway in autumn is served out two or three times a week. There is practically no illness, now that scurvy is mastered, but the settlement has a doctor in residence and a small, well-equipped hospital. Several women have wintered and children have been born in Spitsbergen. A school and a church are to be built. Several centuries ago Spitsbergen had an even larger town occupied only during summer. That was Smeerenburg, the Dutch whaling settlement, which had a population of over 1,000, and contained shops, bars, and other amenities of civilization. With the decline of whaling the town was abandoned, and scarcely a trace remains to-day.

The geological structure of Spitsbergen, broadly speaking, shows two contrasted districts. Along the west coast and in the north of the archipelago there is a zone of old rocks ridged into mountain folds, and subsequently weathered into the sharp peaks which gave the country its name, while in the central and eastern parts there is a broad zone of newer rocks lying in the main in horizontal or gently inclined strata, and weathered into table-topped mountains. In the old rocks there are various metallic ores, including the iron-ore of Prince Charles Foreland, but it is in the newer rocks that the great coal deposits occur. Coal of three geological ages is found, Carboniferous, Jurassic, and Tertiary. Of these the Jurassic coal was first mined, but it proved to be of poor quality, and is no longer worked. The Tertiary coal, unlike the coal of that age in most countries, is of high calorific value and good for steam purposes. It is the principal coal mined at present. There appear to be several seams ranging in thickness from $3\frac{1}{2}$ to 7 feet. Only one of them shows the least tendency to pass to lignite. The Carboniferous coal is a later discovery than the others, because its outcrops are frequently obscured by screes and slip masses, but the deposits are very extensive. It is the only coking coal in Spitsbergen. There are many seams totalling over 6 feet. There is little doubt that the total content of coal in Spitsbergen is over 5,000,000,000 tons.

Conditions are favourable for coal-mining. The extensive faulting of the almost horizontal strata has caused deep waterways into the heart of the country. Icefjord and its branches, and Lowe Sound lead to most of the coal seams. The coal can be reached easily by almost level adits into the hillside within a few hundred yards of good anchorage. The low temperatures prevent flooding and obviate the necessity for extensive pumping. Gas is practically unknown. Frost also helps to maintain a firm roof, and so reduces the

[*Continued on p.* 26

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number of pit-props required. Mining continues throughout the year, the winter coal being stocked for export during the summer months.

Of course vessels have to go in ballast to Spitsbergen to load coal, as there are no northward cargoes except mining and building material, and food, but the distance from Norwegian ports is short, so that this is not a serious drawback. In fact, the chief difficulty in mining in Spitsbergen is not a material one, but lies in the prejudice against a land in the Arctic which the prevalent Mercator maps show apparently at a great distance from Europe.

It is too early, perhaps, to write of the other possible use of Spitsbergen, namely as a health resort, but it fulfils all the conditions required by people suffering from lung troubles. Some day this will be realized, to the benefit of many sufferers.

The sovereignty of Spitsbergen, after being discussed on many occasions since 1871, was given to Norway last year by the Paris Conference. On the whole the decision was an equitable settlement of a difficult problem. Norway's sovereignty is not absolute over the whole country, for pre-existing estates belonging to non-Norwegians are practically exempt, each being under its own administration, and Norway has no power to interfere with the development of those estates.

BOOKS

Spitsbergen: its Exploration, Hunting, and Mineral Riches, by R. N. Rudmose Brown, D.Sc. (London: Seeley Service, 1919.) (Includes early and modern history.)

No-man's Land, by Sir Martin Conway. (Cambridge University Press, 1906.) (Early history of Spitsbergen.)

First Crossing of Spitsbergen, by Sir Martin Conway. (London: Dent & Co., 1897.)

Reviews of Books

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The object of the expedition was to cross the Antarctic Continent on foot from Weddell Sea to Ross Sea, finding out as much about everything as possible *en route*. To this end the main party, under the leader, started off from the Weddell Sea side, and a second party commenced from Ross Sea. What the results would have been, had the plan of campaign succeeded, we do not know, though we can guess, but unfortunately, from the point of view of getting scientific information of Antarctica, the plan did not succeed. Shackleton's ship, the *Endurance*, got smashed in the ice of Weddell Sea, and he and his men had to leave it and take to the ice. After terrible experiences and great privations they reached Elephant Island. From this place Sir Ernest and a few of the party set out in a small boat over the sea to South Georgia, a nightmare of a journey, and then on foot over the hills and glaciers to Stromness, a whaling station. The rest of the party remaining on Elephant Island were rescued by Shackleton after three unsuccessful attempts to do so, and afterwards he went to the help of the other party which had commenced work from Ross Sea. There was, unfortunately, some loss of life, but most of the men and their leader returned safely to Europe and the war.

This is a book to enjoy before a fire. It has all the things we like to read about or see in books of Polar exploration—the penguins, the pack-ice, the sleigh-dogs, and the photographs. Owing to the failure of the enterprise, no great scientific work was able to be done. Many important problems, however, are raised, if not solved, by the voyage, and some important metecrological results are given in the text and in the appendix. But why should we worry over the lacunæ in our knowledge of those Southern parts, when such a failure has given us this record of adventure?

Side Lights on Shakespeare. By H. DUGDALE SYKES. (Shakespeare Head Press, 7*s.* 6*d.* net.)

The Problem of Hamlet. By J. M. ROBERTSON. (Allen & Unwin, 5*s.* net.)

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One of these is by taking down from the shelf the old textbook on the subject, and commencing again at page 1; the other is by taking up a book which is not a compilation, but a critical study of some small part of the subject, and being led on by it and books of a like nature, till one has enveloped the old subject in a new way.

By actual experience we have found the second of these methods the less depressing, the less likely to make us feel that intellectually we have gone very far downhill, and for those who think with us we recommend a re-study of Shakespeare and his times, beginning with a book like this one by Mr. Sykes, or with Mr. Robertson's excellent essay.

The object of the former book is to show that certain plays traditionally attributed to Shakespeare, and which in the general opinion of scholars may not be wholly his work, may be ascribed to definite men who were writing in Shakespeare's time. Mr. Sykes attempts to show that *Henry VIII*, notwithstanding its place in the first folio, is not Shakespeare's work at all. *The Two Noble Kinsmen* he attributes to Massinger; *Arden of Feversham* to Kyd; *King John* and *King Lear* to Peele; *A Yorkshire Tragedy* and the first two acts of *Pericles* to Wilkins.

Mr. Sykes arrives at these conclusions not from a discovery of new documents, or from any objective piece of evidence, but from the internal evidence of the plays themselves. By comparison of the supposed work of Shakespeare with the works of his contemporaries, he presents a number of remarkable parallels of phrases, words, rhymes, and tricks of writing, and, from these resemblances patiently tracked out, he draws his conclusions.

One must be on one's guard against this sort of thing. It may be all right, but then, again, it may not. But it is unfair to an author to conclude, because in the past a few *poseurs* and quacks have tried their hands at this type of research, that all who do it are such.

Mr. Sykes has tackled his problem with considerable insight and mature judgment, and has spared no pains

in trying to get the truth. That is a great deal, and this book deserves the attentive study of scholars and students.

He is most successful in making out his claims for Peele and for Wilkins. This is Mr. Sykes' first book, we understand, and we look forward to a continuation of his activity in this field of work.

Mr. Robertson's contribution to the problem of Hamlet is an extraordinarily able and stimulating one. The chief theories that have been put forward in the past to explain the difficulties in the character of Shakespeare's most famous creation are described and reviewed. Mr. Robertson shows that many of these are to be ascribed to inconsistencies, attributable to the fact that Shakespeare was not creating a perfectly new play, but was building it up from old sources, especially from the old lost play of the same name by Kyd. Such is the main point, and in working it out the author has written a most interesting and helpful book.

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"But do you think there may be Ghosts of other things, though not of men and women?" says Durdles.

"What things?" says Jasper. "Flower-beds and watering-pots? horses and harness?"

"No. Sounds."

"What sounds?"

"Cries."

"What cries do you mean? 'Chairs to mend'?"

"No. I mean screeches. . . ."

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Introduction to Physical Chemistry. By James Walker. (Macmillan & Co., 16s. net.)

This is the eighth edition of a very old friend of ours, and we are glad to see it in its new and up-to-date form ready for the many thousands of students who are now studying Physical Chemistry for the first time, or brushing up their former knowledge. We know no book dealing with this important subject which is more useful and helpful than this one. To those who have never studied a line of Chemistry, or done an experiment with a test-tube, here is a book which opens up a new field of reading and of interest. To those who are studying Chemistry for any purpose, it is a good introduction to the physical side of the subject.

The importance of a knowledge of physical chemistry in technical processes is now widely recognized, and, as a consequence, the subject is receiving more and more attention both in the class-room and the laboratory, and at the works. To fit workers to acquire and appreciate the many important points involved, a good general introduction to the whole subject is necessary, and this Prof. Walker has written with the maximum appeal to experimental work, and the minimum to higher mathematics.

The new chapters deal with recent discoveries in radio-activity, in crystal structure, and in the nature of the atom, and these chapters should interest the general reader most. Of one of these new pieces of work we shall now give a short account.

Until quite recently there was no special reason to believe that the number of elements known to the chemist was a fixed and definite one. About eighty or so different elements were known, but from time to time research workers announced a new element, and in some cases this discovery was confirmed by others. For all we knew, then, there might really be a hundred or a hundred and fifty elements, and the reason why we had not found them all was simply that we were not clever enough. But this somewhat pessimistic view is no longer tenable. Hydrogen is the lightest of elements, and uranium (a rare element) the heaviest, and between these two substances there are ninety others only.

The chief credit for this discovery belongs to Moseley, a young Oxonian who worked in Manchester, and who was killed in the war. Moseley showed, from a study of the X-rays produced by different elements, that each element has a number which belongs to it, and to it alone. Thus the number that belongs to mercury is 80, to gold 79, to platinum 78, and so on. Now, while every different element has its own particular number, there are some numbers for which there is no known element. There is, for example, no element which, when examined by Moseley's method, corresponds to the number 43. Here, then, is an element which is still unknown, and, if Moseley's work is right, the only elements which are still to be discovered are those for which we have the number but no corresponding substance. If hydrogen's number is taken as 1, uranium's number is 92, so that there are altogether 92 elements. Of course, there may be elements heavier than uranium, or lighter than hydrogen; and, if so, this number 92 would be increased accordingly, but until such are discovered, we may conclude there are 92 only.

Of these the chemist has discovered 86, so that six alone remain to be found. This is extremely creditable to the chemist. Not only has he discovered nearly 94 per cent. of the total number of possible elements, but of the number of bodies which chemists have agreed to look upon as elements, not one was proved, by Moseley's wonderful and illuminating method, to be spurious.

Catalysis in Theory and Practice. By E. K. Rideal and H. S. Taylor. (Macmillan & Co., 17s. net.)

Catalysts are substances which change the velocity of a chemical reaction without apparently themselves taking part in it. Thus if a quantity of alcohol be added to a quantity of acetic acid, a chemical reaction will take place at a definite rate, and will continue till only a small part of the original quantity of alcohol is left. By repeating the experiment and adding to the mixture this time a small quantity of sulphuric acid, the reaction takes place at an enormously increased speed. This small amount of acid has nothing to do with the cause of the reaction, and no influence on the extent to which it goes. Its action is simply to "speed-up" things. Such accelerators, it will be realized, are of great importance in industry, in the manufacture of substances, for example, like indigo, ammonia, and alcohol, for there is no kind of chemical reaction which cannot be influenced by these catalytic substances.

The authors of this work have made a valuable compilation of the chief phenomena associated with catalysis, studied both from the practical and the theoretical side. It should be a serviceable textbook for all "finished" chemists.

The World's Minerals. By L. J. Spencer. (Chambers, 10s. 6d. net.)

An excellent book for the general reader by one who is well qualified to write on his subject. It gives an interesting and very readable account of the more important minerals. The title rather suggests that the book deals with minerals from a commercial or economic view, but this is not so. The place that minerals occupy in commerce as ores of metals, as gems, and so on, is of course mentioned, but the book deals chiefly with the appearance, structure, and characteristics of the minerals themselves. More than a hundred are described. The diagrams are clear, and the coloured plates, illustrating the minerals, are really excellent.

The Amœbæ Living in Man. By Clifford Dobell. (John Bale, Sons & Danielsson, 7s. 6d. net.)

This book is written by one whose chief interest in the subject is from the zoological standpoint, and its appeal is both to research workers in protozoology, and to doctors who are making a special study of the diseases produced by protozoa, especially dysentery. Knowledge concerning the amœbæ living in man has hitherto been in a state of some confusion. Mr. Dobell has set himself the task of collecting the true facts of the subject, and from an exhaustive study of the literature, a large personal experience of research, and from the exceptional opportunities that the war has afforded him of studying a very large number of cases, he has been able to advance our knowledge of these amœbæ to a state approaching finality. He has put his readers on their guard against many erroneous facts and conclusions which appear in the literature and the textbooks. Medicine and Zoology alike are indebted to the author for this accurate, exhaustive, and illuminating work. It is hoped that the results and conclusions given in this book by Mr. Dobell, and his classification of the genera of amœbæ, will find a place soon

in the newer textbooks. A valuable bibliography is appended.

The Army and Religion. An Inquiry, and its Bearing upon the Religious Life of the Nation. (Macmillan & Co., 6s. net.)

During the war, a committee, of which the joint-conveners were the Bishop of Winchester and Professor Cairns of Aberdeen, was formed to make an investigation, as complete as possible, of the attitude of serving soldiers towards religion and the Church. A questionnaire was prepared and widely circulated among all ranks; the replies to the questions were carefully analysed, and from the analysis such facts as were plain, and such conclusions as could be honestly drawn, were set down. The result is this book, a work of great importance and of vital interest to everyone interested in the men who fought in the war, and to those anxious for the welfare of the country in these first years of peace.

Some of the questions set or suggested to those who replied are these: What do the men think about Religion, Morality, and Society? Now that conventions are set aside, what faith and standards are the men living by? What are the chief difficulties in the way of belief independently of those raised by the war? What do they criticize in the present social order? Has the war made any real difference in their moral and religious outlook and character? Has it made them think more deeply? Are the men interested in how to bring about a better world and an enduring peace? Do intellectual hindrances count for much in producing indifference to the Churches?

The first part of the book deals with the numerous answers received to these and other questions; in the second part the answers are ably and sympathetically discussed.

The book gives a reader lots to think about. There is a candour and spontaneity about it that is very attractive. No attempt is made by the compilers to ram any ready-made theories down one's throat. They have given the facts of the matter as they have come to their knowledge. It is for the reader to consider these, to agree with or criticize them, and to act.

Other Publications Received

A New School in Belgium. By A. F. de Vasconcellos. (Harrap, 5s. net.)

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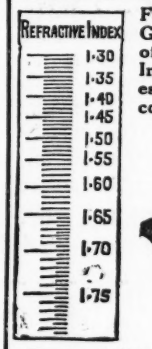

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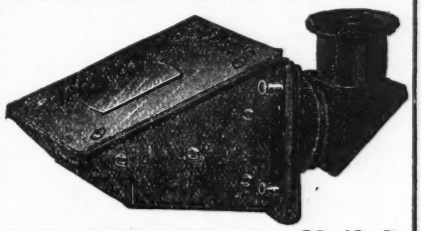

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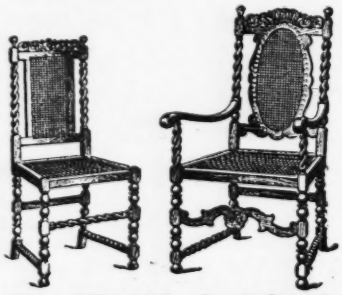

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